

OVERALL EXPECTATIONS

- analyze the economic and environmental advantages and disadvantages of an artificial selection technology, and evaluate the impact of environmental changes on natural selection and endangered species
- investigate evolutionary processes, and analyze scientific evidence that supports the theory of evolution
- demonstrate an understanding of the theory of evolution, the evidence that supports it, and some of the mechanisms by which it occurs

BIG IDEAS

- Evolution is the process of biological change over time based on the relationships between species and their environments.
- The theory of evolution is a scientific explanation based on a large accumulation of evidence.
- Technology that enables humans to manipulate the development of species has economic and environmental implications.

UNIT TASK PREVIEW

In this Unit Task you will choose a current topic in applied evolutionary biology from medicine, conservation biology, agriculture, or from a field of your choosing. You will complete an analysis of the application, reviewing the evolutionary principles at work, what the theory predicts, and how the theory is applied to the situation in question.

The Unit Task is described in detail on page 378. As you work through this unit, look for the Unit Task Bookmarks to see how information in the section relates to the Unit Task.



IN PURSUIT OF POISONS

Poisons can make powerful medicine. At first this might sound like a contradiction. How can a poison be of medical benefit? The answer lies in what ails you. We use a variety of drugs to kill infectious bacteria and parasitic organisms that have invaded our bodies. We also try to kill our own cells if they have become cancerous and are dividing out of control. Antibiotics, chemotherapy drugs, and other medicines are poisonous to their intended target. How do scientists go about finding these “poison pills”?

Many poisons are produced by living organisms. In their search for these poisons, evolutionary biologists often look for situations in which there is an ongoing evolutionary “arms race” between predator and prey or between pathogen and host. In these situations a species may have evolved chemical defences to deter a predator or to fight off infectious organisms.

The tropical rainforests of Central and South America are home to some dramatically coloured poison dart frogs. Their bright coloration serves as a warning to would-be predators that these frogs contain poisons. In addition to the poisons these particular frogs use to ward off predators, all frogs produce antimicrobial chemicals in their skin to resist infections. More than 100 of these chemicals have been isolated, and at least one is able to kill some strains of highly drug-resistant bacteria. Researchers believe these substances could become the basis for a powerful new generation of antibiotics. Ironically, the existence of many of these same frog species is threatened by a serious fungal skin disease. The fungus is being introduced to new ecosystems by human activity. Without previous exposure to the fungus, many frog species have not had an opportunity to evolve a chemical defence against it.

Scientists apply evolutionary or Darwinian thinking to all aspects of healthcare and indeed to all aspects of biology. As you will learn, the theory of evolution provides important insights and informs our understanding of individuals, species, communities, and entire ecosystems. Evolutionary biology is a vital tool for maintaining and enhancing our own health as well as that of the diversity of life on Earth.

Questions

- Many potent medicines are derived from plant toxins, while relatively few come from animal sources.
 - Why might plants have evolved more poisons than animals?
 - Would you expect plant poisons to be more concentrated in leaves, fruits, or roots? Explain your reasoning.
 - Fruits and roots make up a larger portion of a typical human diet than leaves. Are you surprised? Explain.
- Given that many drugs are actually biological poisons designed to kill certain types of cells, is it surprising that many drugs have adverse side effects? What does this suggest about the challenges of developing safe and effective drugs to combat disease?
- When exposed to sunlight, human skin produces vitamin D, an extremely important compound. Biologists are concerned that lifestyle changes could cause widespread vitamin D deficiency. How does this concern reflect Darwinian thinking?
- Some species of Amazonian snakes are able to eat poison dart frogs. How does this illustrate the concept of an evolutionary arms race?



CONCEPTS

- recognize and use proper terminology related to genetics and reproduction
- explain the significance of mutation and genetic variation
- understand scientific approaches to gathering evidence and testing hypotheses
- understand ecological relationships and adaptations

SKILLS

- interpret phylogenetic trees
- calculate simple ratios and probabilities
- evaluate information sources

Concepts Review

- Describe the structure and function of each of the following: **K/U**
 - chromosome
 - DNA
 - gene
 - allele
- Explain the meaning and relationship between the terms “haploid,” “diploid,” and “polyploid.”
 - Under what circumstances do diploid and polyploid organisms produce haploid cells? **K/U**
- Explain how each of the following processes contributes to genetic diversity: **K/U**
 - independent assortment of homologous chromosomes
 - crossing over
 - mutation
- Assume that a portion of a DNA molecule has the following base sequence: A A T C G T T C A C G G. Rewrite this sequence to illustrate an example of
 - a base substitution
 - a deletion
 - an insertion **K/U**
- What causes mutations to occur? **K/U**
- Why are mutations described as being neutral, beneficial, or harmful? Provide examples to support your answer. **K/U**
- It is sometimes possible for a mutation to be beneficial in one situation and not in another. What role does the environment play in creating these different situations? **K/U T/I**
- Many species are involved in symbiotic relationships with other species. Define and give an example of each of the following forms of symbiosis: **K/U**
 - mutualism
 - commensalism
 - parasitism

- Figure 1** shows a Venn diagram. Copy Figure 1 into your notebook and complete it to compare asexual and sexual reproduction. Include references to genetic diversity, advantages, disadvantages, and the cellular processes involved. **K/U T/I**

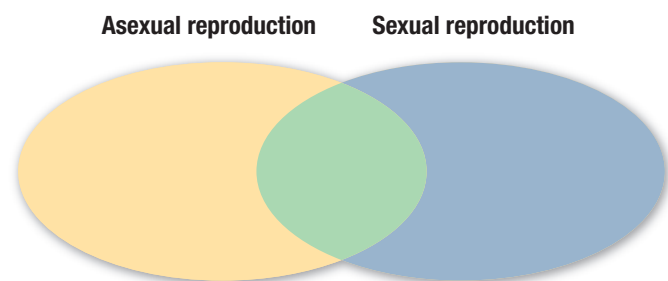


Figure 1

- What are the advantages to a population or species that has a high degree of genetic variation? **K/U**
- Many species occupy similar ecological niches in different parts of the world. Brainstorm examples of the following: **T/I**
 - a top carnivore in Africa and a top carnivore in North America
 - a large grass-eating herbivore in the Canadian prairies and a large grass-eating herbivore in an African savannah
- What are invasive species?
 - Why are invasive species able to outcompete species that are native to a particular area? **K/U T/I**
- Over the past 60 years, many species of bacteria have become resistant to one or more types of antibiotics. **T/I C A**
 - Make a series of labelled diagrams to describe and explain how antibiotic resistance develops over time.
 - Would a mutation that increases antibiotic resistance in a species of bacteria be considered harmful or beneficial? Explain.

14. Examine the photograph of the poinsettia plant in **Figure 2**. T/I A
- Would you expect this plant to be wind or animal pollinated? Explain your reasoning.
 - What are often thought of as red poinsettia “flowers” are actually brightly coloured red *leaves*. Most plants produce only green leaves. What type of genetic event might have produced this trait in the poinsettia?
 - What other plants have leaves that perform a non-photosynthetic function? How is this trait advantageous to those particular plants?



Figure 2

- Explain the advantages of each of the following adaptations to life on land: T/I
 - Gymnosperms produce pollen and seeds.
 - Mammals and birds are warm-blooded.
- What is the difference between a scientific hypothesis and a scientific theory? Under what circumstances can a hypothesis eventually become a theory? T/I
- Scientists rely heavily on carefully controlled observations of the natural world and experiments for gathering data. Galileo, for example, believed that the only way to determine if a heavy ball falls faster than a lighter ball was to drop them and measure their speed. Do you agree with Galileo? Is there a better or more reliable way to find out which ball falls faster? T/I

Skills Review

- Make the following conversions based on the scales provided: K/U
 - scale: 1 m = 200 years
conversion: _____ m = 8000 years
 - scale: 1 m = 50 MY (million years)
conversion: 35.5 m = _____ years
- Insert the correct value to produce a matching ratio: K/U
 - The ratio 6:4 is equivalent to ____:20.
 - The ratio 11:3 is equivalent to 44:_____.

- Examine the phylogenetic tree in **Figure 3** and answer the following: K/U
 - Which species is most closely related to wheat? Explain.
 - Which are more closely related: ferns and moss, or ferns and orchids? Explain.
 - Kelp are not plants. According to this diagram, do kelp share a common ancestor with each of these plant species? Explain.
 - According to this diagram, what shared common ancestor places ferns in a clade with spruce?
 - What shared common ancestor excludes ferns from the *largest clade that does not include the fern*?

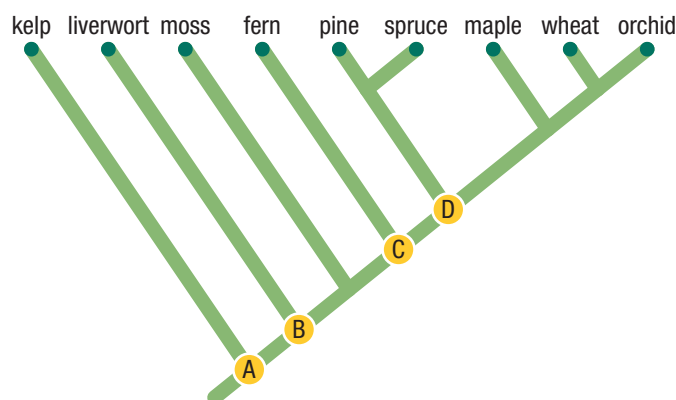


Figure 3

- A population contains two types of individuals: type A and type B. The population consists of 40 individuals. Determine how many are A and how many are B, if they occur in the following ratios. Round off to the nearest whole number. K/U
 - 4A:1B
 - 2A:3B
 - 11A:5B
- What is a science journal?
 - What are the advantages of peer review?
 - What is an abstract? K/U T/I
- Students often use the Internet as a tool for conducting online research. When you use the Internet, what criteria can you use to determine whether or not the information on a website is credible? T/I



CAREER PATHWAYS PREVIEW

Throughout this unit you will see Career Links in the margins. These links mention careers that are relevant to evolution. On the Chapter Summary page at the end of each chapter you will find a Career Pathways feature that shows you the educational requirements of the careers. There are also some career-related questions for you to research.